# Building Networks for the 22nd Century

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## This presentation

In Scope
- Residential buildings
- Commercial buildings
- Human beings

Not in Scope
- Industrial energy use
- Sensor networks
- The meter
- **Anything** on the grid side of the meter



## Background

My Orientation
- Electronics energy use (e.g. Energy Star)
- Networks (standards; many layers)
  - IEEE, Ecma, IEC, CEA, …
- User interfaces

This presentation
- My views only
- High ratio of assertions to explanations
  - Pleased to continue discussion later



## Fundamentals

Electronic networks (IT, CE)
  - Information Technology, Consumer Electronics
- Basis: Information
- Functionality: Well-developed
- Energy: Mixed results

Building networks
  - Lighting, climate, appliances, misc., security*, …
- Basis: Physics
- Functionality: Not well developed
- Energy: Too early to say



## Context

- Not inevitable that building networks will save energy
- Networks of IT and CE products significantly increased energy use
  - We have much to learn from electronic networks and Internet; theory and reality
- Much (most?) activity in building networks is driven by short-term business interests, not saving energy
- "Home Automation" to date rarely informed by energy
- Building networks best understood as a means to provide functionality, NOT as a means to save energy

## Core Principle

### Universal Interoperability

*Any device should work with all other objects in any space*

- Across building types
  - Residential, commercial, vehicles, …
- Across geography
  - Countries, language, …
- Across time
  - Worthy of durability
- Across people
  - Age, disability, culture, activity / context
- Across end uses
  - Coordination, cooperation



## Key challenge

**Representation of *real* world in *information* world**

- Need a standard "dictionary" of things, ideas, principles, actions, etc.
  - Embody these in protocols, data dictionaries
  - Embody in user interfaces
- Standardization of core ideas, terms, and underlying metaphors
  - the meaning (semantics) of the information
  - not how it is encoded or represented (except in the UI)



## Standard Concepts

- Building elements (energy using or not)
  - Lights, climate control devices, windows, displays, rooms, sensors, appliances, …
- Ideas
  - Presence, schedules, prices, events, …
- Characteristics
  - Physical location, power levels, light
- Actions
  - Dim, open, go to sleep, …
  - Announcing and requesting

Concept of "affordances"



## Standard Concepts Elsewhere

- Those reflected in User Interfaces
  - Tape transport: Play, pause, stop, fast-forward, eject, …
- Document conventions
  - Fonts, margins, headings, columns, …
  - Web page conventions: forward, back, navigation, links, …
- Data and File formats
  - ASCII, PDF, HTML, …
- Email conventions
  - Structure, addressing, …



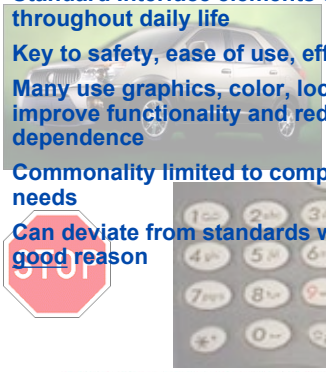
## Role of People

- People often absent from design, presentation
- Humans are best understood as nodes on the network
  - Even more than portable electronics, they move
- People, like devices, need standard interfaces
  - Nature of interface different, but principle same
- User interface design should be starting point
  - Then create dictionary
  - Then design protocols
- Ensure that devices are adaptable to different people
  - Needs, desires, capabilities



## User Interfaces

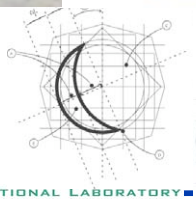
- **Standard Interface elements common throughout daily life**
- **Key to safety, ease of use, efficiency**
- **Many use graphics, color, location, etc. to improve functionality and reduce language-dependence**
- **Commonality limited to comprehension needs**
- **Can deviate from standards when there is a good reason**



## User Interfaces

- Consistent across:
  - Manufacturers
  - Products
  - Countries
- Simple
- Accessible
- Portable

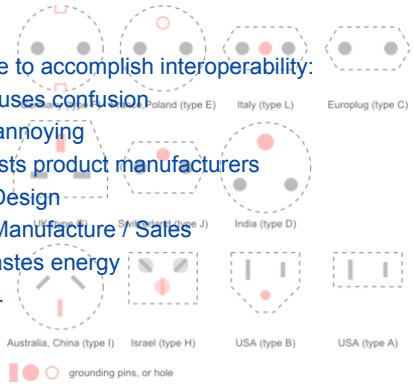
***Key Elements***
- *Terms*
- *Symbols*
- *Colors*
- *Metaphors*
- …





## Non-Interoperability

- Failure to accomplish interoperability:
  - Causes confusion
  - Is annoying
  - Costs product manufacturers
    - Design
    - Manufacture / Sales
  - Wastes energy
  - ….






## Complexity

While some integrators are skeptical about the prewired, preprogrammed NHS rack from Sony, others embrace the solution for its simplicity.

- Complexity is easy
  - Ordinary outcome
- Simplicity (and power) is hard
  - Doable
  - Well worth effort



## Technical Approaches

- Adopt standard network technology up through TCP/IP for building networks
  - No reason to duplicate
  - Need to share infrastructure and interoperate with electronic devices
  - Want connectivity to Internet
- Be prepared to jettison any/all existing technology
  - For product, standards design only
  - Need gateways to legacy systems for extended period
- Path to future requires some "leaps" in technology and standards
  - Incrementalism alone is the path to mediocrity
- If devices interoperable with people, much easier to be interoperable with each other



## Next Steps

- Adopt goal of "Universal Interoperability" and use of IPv6
- Organize all relevant standards orgs. to play proper role; engage Rest of World
- Create Building Network Task Force (BNTF) as sibling to Internet Engineering Task Force (IETF)
- --IETF is part of Internet Society (isoc.org)
- Fund academic research on key topics
  - Network architecture
  - Presence, authority, security, user interfaces, protocol design, …
- Revisit related topics in light of this
  - Real-time pricing, demand response, "smart grid", …
- Get started ASAP



## What about the "Smart Grid"

- If the "Smart Grid" stops at the meter:
  - I have nothing to say
- If the "Smart Grid" extends through the meter:
  - (I assume real-time pricing; don't care how transmitted)
  - Suggests one architecture that extends from power plant to each end-use device
  - Will impede improvements in grid
  - Will impede improvements in buildings
  - No barrier to occasional "opt-in" agreements / exchanges between devices and outside entities
    - Demand response, local generation and storage, ..
  - The meter is our friend


Thank you!
HEATERS ON
RESTORE
HEATERS OFF
OFF
STAND-BY POWER
INITIAL CLEAR 1
INITIAL CLEAR 2
CLEAR FFTs